

Cockroaches (Insecta, Blattodea) from caves of Polillo Island (Philippines), with description of a new species

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Abstract

Cockroaches collected during a protracted series of fieldwork in several limestone caves in Polillo Island, Philippines were taxonomically studied. A new species of *Nocticola* (Nocticolidae), *N. gonzalezi* Lucañas & Lit, **sp. n.**, is described. The male of *Periplaneta banksi* Hanitsch (Blattidae) is described for the first time. Altogether, the present cave cockroach fauna of the island consists of six species.

Keywords

Blaberidae, Blattidae, Burdeos, cave cockroaches, Ectobiidae, Nocticolidae, troglobiont

Introduction

Cockroaches are well represented in cave ecosystems. They are classified as: troglaxene, troglophile, guanobyte or troglobiont depending on their specialization or adaptation to the cave environment (Chopard 1936, Roth and Willis 1960). Juberthie (2000) estimated that there are at least 31 species of troglobiont or obligate cavernicolous cockroaches worldwide but additional species are still waiting to be described.

Unfortunately, very few studies have been conducted regarding the diversity of Philippine cockroaches, maybe because the group includes species that are considered

household pests. Thus, limited information is available on the country's fauna, especially in cave ecosystems. In recent years, the increasing interest in cave studies in the country has provided an opportunity to study the diversity of cockroaches in Philippine limestone caves.

The first documented troglobiont cockroaches in the Philippines were species of Nocticolidae from Rizal Province (Bolivar 1982), a few kilometers to the east of what is now Metro Manila. These were: *Nocticola simoni* Bolívar, 1892 (from a cave in San Mateo town), and *Nocticola caeca* Bolívar, 1892 (from Cueva de Talbac, in what is now Antipolo City). Roth (1988) also noted an unidentified *Nocticola* nymph from a cave in Montalban town (now called Rodriguez), also in Rizal Province, deposited in the Natural History Museum, Geneva, Switzerland.

Unfortunately, due to the limited knowledge on Philippine cockroach diversity, many species have often been misidentified. Encinares and Lit (2014) listed species found in caves in Polillo, including what they initially identified as Cryptocercidae sp. and Blattidae spp. 1, 2, 3 and 4. Lucañas et al. (2015) later clarified their identities to be *Pycnoscelus striatus* (Kirby, 1903) and *Hemithyrsochera* sp.

Mag-usara and Nuñez (2014) reported *Polyzosteria limbata* Burmeister, 1838, *Calolampra irrorata* (Fabricius, 1775), *Methana marginalis* (Saussure, 1864) and *Ellipsidion* sp. from several caves in Siargao, Surigao del Norte. Although, we were not able to examine the specimens, it is likely that those cockroaches have been misidentified as the mentioned species are all restricted to Australia. Similarly, *Polyzosteria* and *Eublaberus* sp. have been reported from a cave in Lanao del Norte (Macud and Nuñez 2014, Sobrepeña and Nuñez 2014), which are known only from Australia and the neotropics, respectively.

Other than those, there have been very few studies regarding the diversity of cockroaches in caves. This paper provides a list of cockroaches collected from several caves in Polillo Island, Quezon Province in the Philippines.

Materials and methods

All examined specimens were either pinned (for larger specimens) or preserved in vials of 95% ethyl alcohol, unless otherwise indicated as mounted on slide using Canada Balsam. Slide preparations were made starting with cold maceration by soaking in 10% aqueous Potassium Hydroxide (KOH) solution for 24 hours at ambient room temperature. They were then washed in distilled water to remove unwanted undissolved internal contents, and then run through graded alcohol series and then anhydrous clove oil to remove excess ethanol. Finally, they were mounted on microscope slides using Canada Balsam. The following parameters were measured using a calibration micrometer for pinned specimens and calibrated ocular micrometer for slide mounted specimens:

TL (Total length) the length from the tip of the vertex (if exposed) or pronotum up to the tip of the tegmina at rest;

- BL** (Body length) the length from the tip of the vertex (if exposed) or pronotum up to the tip of the subgenital plate (in case of brachypterous/micropterous/apterous species, total length = body length);
- Pn** Pronotum length $\times$ width along the longest axis;
- Tg** Tegmina length along the longest axis.

Standard deviations for each measurement were also noted. Terminologies used for male genitalia follow Klass (1977), and Roth (2003) for other characters such as fore femoral armaments (Type A (robust spines terminating to 2–3 terminal spines), B (several proximal spines followed by row of smaller spinules with 2–3 terminal spines) and C (row of piliform spinules with 1–2 terminal spines)).

Illustrations were made by tracing printed photomicrographs of clear slide-mounted specimens. The degree of sclerotization and pigmentation was made through line thickness and by stippling. All specimens are deposited in the Entomological Collection of the UPLB-MNH.

Taxonomy

Family Nocticolidae Bolívar, 1892

Genus *Nocticola* Bolívar, 1892

***Nocticola gonzalezi* Lucañas & Lit, sp. n.**

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Figure 1

Material examined. *Holotype*: male, slide-mounted. Original label: “Philippines: Polillo Island (Quezon Province): Cave 5, Sitio Puting Bato, Barangay Aluyon, Burdeos, 13.v.2013 CC Lucañas” “UPLBMNH BLA-00220”, “HOLOTYPE / *Nocticola gonzalezi* Lucañas & Lit [laser printed on red slide label]”

Paratypes: 1 male, 1 female, 5 nymphs, same locality as holotype but 10.x.2013: (CC Lucañas, UPLBMNH BLA-00221, ♀ (slide); -00222, ♂; -00223, nymph (slide); -00224a-d, 4 nymphs). “PARATYPE / *Nocticola gonzalezi* Lucañas & Lit [laser printed on blue slide label or handwritten on blue label]”.

Type locality. Philippines: Polillo Island (Quezon Province): Cave 5, Sitio Puting Bato, Barangay Aluyon, Burdeos, on calcite rubble with insectivorous bat guano.

Diagnosis. Male brachypterous; female apterous. Compound eyes reduced, much smaller in female. Femur Type C₁. Tarsi simple, symmetrical. Tergal gland absent (*simoni*-species group). Accessory hook-like phallomere (L2d) dagger-like.

Roth (1988) noted the difficulty in separating nocticolid genera. Although Chopard (1945, 1966), being unable to differentiate *Nocticola* from *Alluaudellina* Chopard, 1932 noted the possibility of the two being synonyms, *Nocticola* differs from the latter by the absence of styles. Aside from *Nocticola*, only *Cardacus* Strand, 1928 lacks style in the

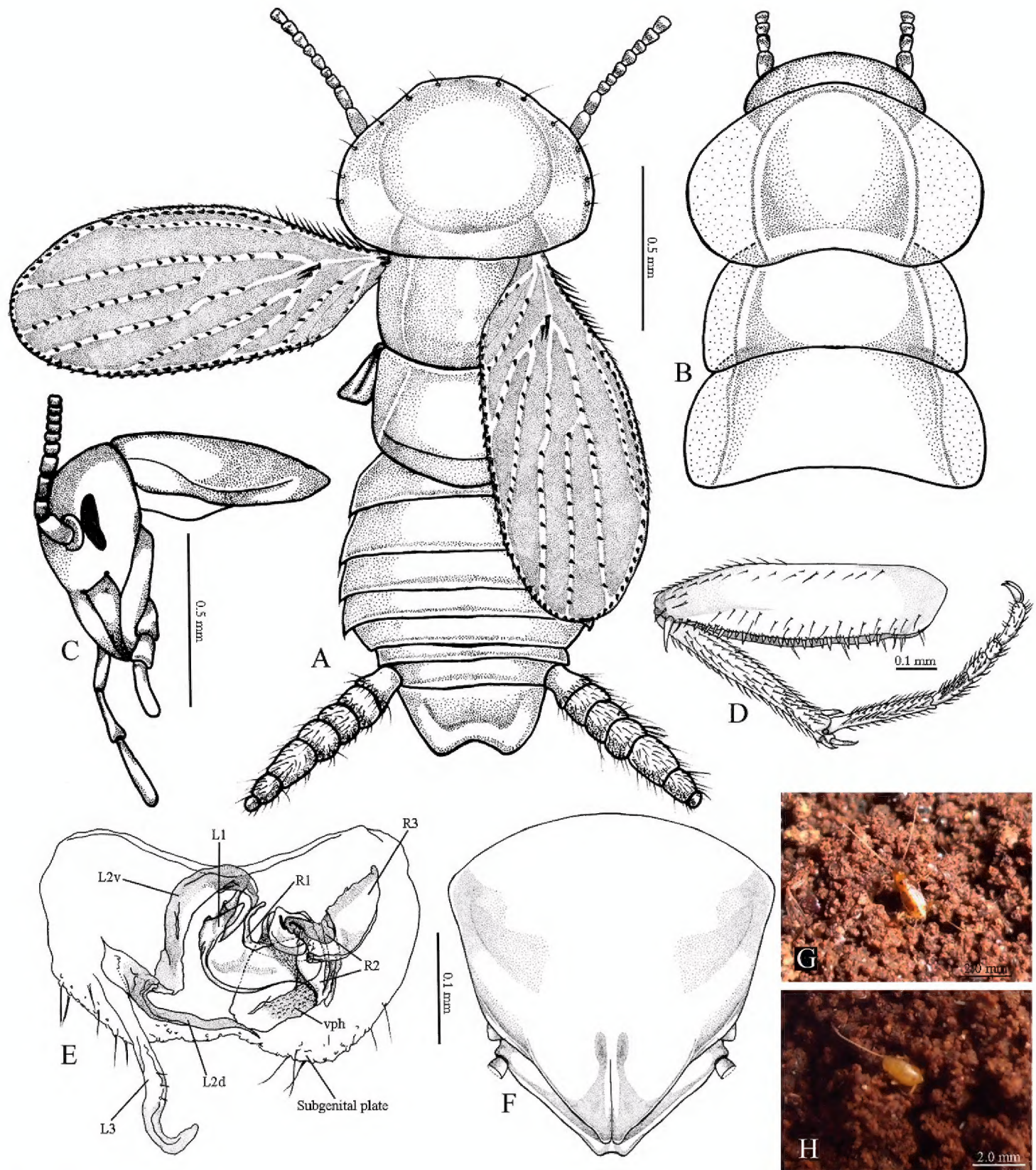


Figure 1. *Nocticola gonzalezi* Lucañas & Lit, sp. n.: **A** Adult male **B** adult female **C** male head, lateral aspect **D** Prothoracic leg **E** male genitalia: (L1-3: sclerites of left phallomere; L2d: L2 dorsal; L2v: L2 ventral; R1-3: sclerites of right phallomere; vph: ventral phallomere) **F** female subgenital plate **G** male and **H** female habitus.

family. The former is distinguished from the latter by the absence of ocelli and exposed vertex. Following such dichotomy, this new species is placed under *Nocticola*.

This species can be distinguished from other troglobiotic *Nocticola* by the presence of an accessory hook-like phallomere which was only reported from two epigeal species, *N. scytala* Andersen & Kjærandsen and *N. clavata* Andersen & Kjærandsen from Ghana, West Africa (Andersen and Kjærandsen 1995).

This species is similar to *N. simoni* and *N. caeca* in terms of coloration but differs in terms of size, *N. gonzalezi* being smaller. Unfortunately, the male genitalia of *N. simoni* and the male of *N. caeca* was not described by Bolivar (1892) and the location of the type specimens are unknown (Paris 1993).

Many *Nocticola* species are narrow endemics even among caves within a contiguous area (e.g. *N. simoni* was collected from a cave in San Mateo, Rizal Province and *N. caeca* from nearby Antipolo, also in Rizal Province). Considering this, as well as the morphological characteristics and the isolation of Cave 5 in Puting Bato, Burdeos, Polillo Island, we iterate the distinctness of *N. gonzalezi*.

Description. Size (mm): ♂, TL: 2.36 ± 0.13 mm; Pn: $0.50 \pm 0.10 \times 0.93 \pm 0.05$ mm; Tg: 1.13 ± 0.2 . ♀ TL: 2.5 mm; Pn: 0.50×0.95 mm.

Male. (Fig. 1A,G). Yellowish brown throughout except for light brown pronotum and tegmina. Vertex of head slightly exposed; eyes reduced but larger than those of female (Fig. 1C); ocelli absent. Pronotum wider than long. Forewing reduced, venation simple indicated by spinules, rounded at apex; hind wing highly reduced, triangular with single vein. Legs very long, forefemur Type C₁ (Fig. 1D); mid- and hind femur with apical spines; mid- and hind tibia with several minute spines on outer aspect; hind metatarsi longer than the rest; pulvilli and arolia absent, tarsal claw simple, symmetrical. Abdominal tergal gland absent (*simoni*-species-group (Roth 1988)). Supra-anal plate symmetrical. Style absent. Genitalia as illustrated (Fig. 1E), genital hook (L3) conspicuous, extending well beyond subgenital plate. Accessory hook-like phallomere (L2d) dagger-like.

Female. (Fig. 1B,H) Larger than male. Opaque yellow throughout except for lateral thoracic margins. Apterous. Supra-anal plate triangular. Subgenital plate broad basally, valvular.

Nymphs. Similar to female. Opaque white. Eyes reduced to 3-4 distinct facets.

Etymology. The species is named after Dr. Juan Carlos T. Gonzalez, the current director of the UPLB-MNH, in recognition of his pioneering efforts toward biodiversity documentation and conservation in the Polillos, a group of islands, east of Luzon and politically a part of Quezon Province.

Distribution. Philippines: Polillo Island.

Ecology. Collected only from a single cave in Burdeos, Polillo Island, Quezon. The cave is deposited with porous calcite rocks and thin guano deposits from periodical roost of insectivorous bats, *Hipposideros coronatus* (Peters, 1871) and *Miniopterus schreibersii* (Kuhl, 1817). The site is relatively dry and rocky compared to the damp and sticky clay that is found throughout the rest of the cave, especially during the rainy season. They are quite fast and usually hide among the holes in the calcite rocks. They are found among and probably serve as prey for nymphs of whipspiders (Arachnida: Amblypygi), whipscorpions (Thelyphonida) and adult short-tailed whipscorpion (Schizomida).

Conservation status. Due to the narrow distribution of this species, it is suggested that the species be considered "Vulnerable" and that the cave from which it was collected be protected from further anthropogenic disturbances.

Remarks. Because of its morphological characteristics, this species can be classified as a true cave-dweller or troglobiotic.

Family Blattidae Stephens, 1829**Genus *Periplaneta* Burmeister, 1838*****Periplaneta banksi* Hanitsch, 1931**

Periplaneta banksi: Hanitsch 1931: 401 (Holotype: ♂, Philippines, The Natural History Museum (BMNH), London); Bruinjing 1948: 110; Princis 1966: 441; Asahina 1980: 113.

Material examined. 8 males, 10 females, 3 nymphs: Philippines: Polillo Island (Quezon Province): Bulalon Cave, Poblacion, Burdeos, 23.ii.2013 (IL Lit, Jr/ OL Eusebio/ AR Larona, UPLBMNH BLA-00232-00234, ♂, -00235 ♀); 25.v.2007 (IL Lit, Jr/ OL Eusebio/ AR Larona, UPLBMNH BLA-00236-00242, ♂, -00243-00245, ♀, -00246-00248, nymphs); 11.vi.2008 (OL Eusebio, UPLBMNH BLA-00528-00531, ♀).

Diagnosis. Reddish-brown throughout. Fore femur A_2 (Fig. 2C). Tegmina well developed (Fig. 2A). Arolia minute. Tarsal claws simple, symmetrical. Male supra-anal plate symmetrical, deeply divided, each lobe rounded and with minute round projection apically (Fig. 2G). Cerci erect, pointed (Fig. 2G). Genital hook (Fig. 2E: L3) angulate, with minute sub-apical process.

Hanitsch (1931) noted the relatively large size of the species compared to other *Periplaneta* species.

Description. *Size* (mm): ♂ TL: 45.71 ± 2.29 ; BL: 37.42 ± 3.69 ; Pn: $11.57 \pm 0.79 \times 14.86 \pm 1.46$; Tg: 35.71 ± 2.29 ; ♀ TL: 48.5 ± 2.01 ; BL: 41 ± 2.53 ; Pn: $11.6 \pm 0.51 \times 15.8 \pm 1.03$; Tg: 37.7 ± 2.41 .

Male. Reddish-brown throughout. Vertex exposed. Ocelli present. Pronotum wider than long, markings indistinct. Tegmina well-developed, extending beyond abdomen. Fore femur A_2 . Pulvilli present on four proximal tarsi. Minute sub-apical spine present on three proximal tarsi. Mid- and hind tibia with several minute spines on outer aspect. Hind basitarsus longer than succeeding tarsi combined. Arolia minute. Tarsal claws simple, symmetrical. Abdominal tergal gland absent. Supraanal plate testaceous, deeply divided, each lobe rounded with minute round projection. Genitalia as illustrated, genital hook angulate, with minute sub-apical process.

Female. Similar to male except that supra-anal plate rounded with deep division. Subgenital plate valvular.

Distribution. Philippines, Taiwan

Ecology. This is the first record of the species inside caves. The species is abundant and most individuals hid among the crevices of the cave walls. They were found from the twilight to the dark zone. Nymphs and mating pairs were often seen, suggesting that the species can complete their life cycle within the cave. Despite that, *P. banksi* is classified as troglophilic because of the lack of distinct troglobiotic characters and the possibility of the species surviving outside cave conditions.

Both nymphs and adults are possibly preyed upon by whipspiders, *Charon* sp., and huntsman spiders, *Heteropoda* sp.

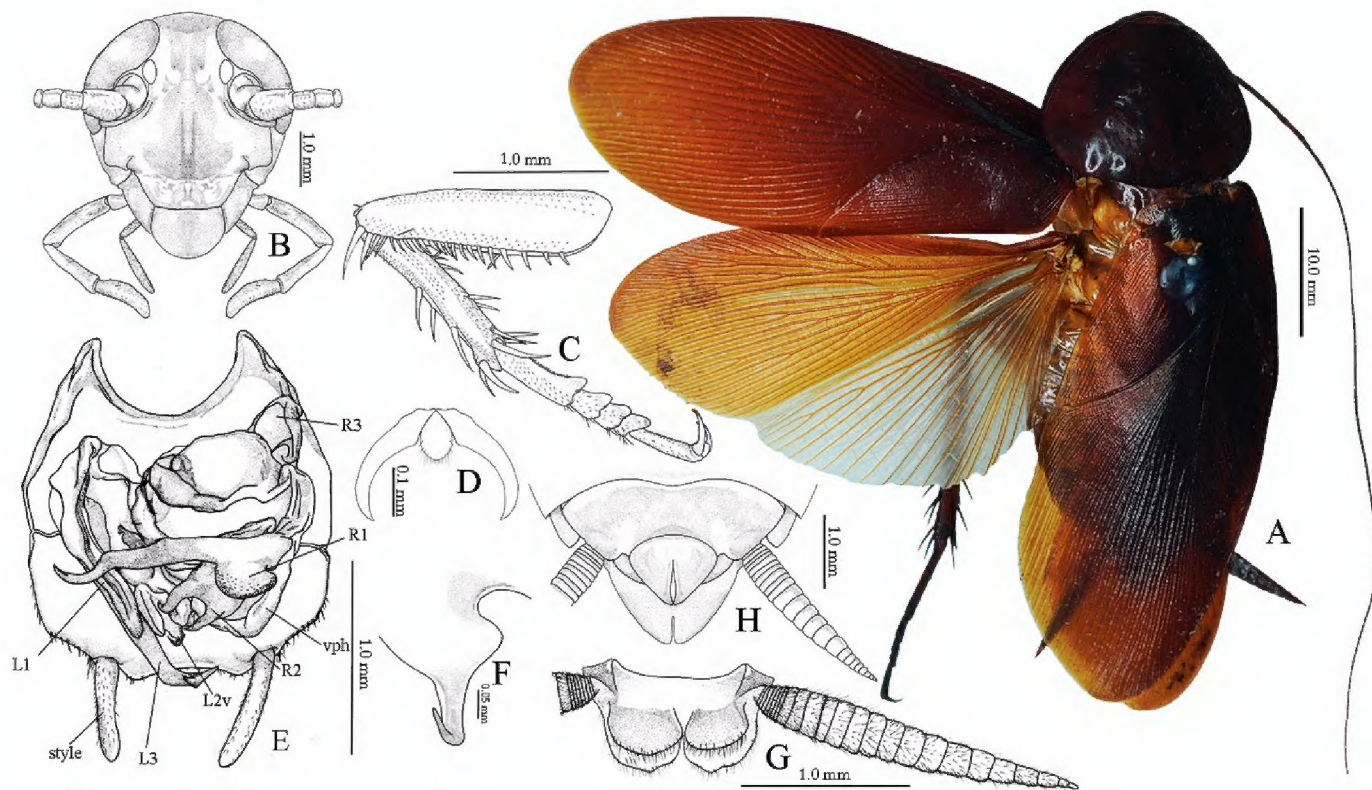


Figure 2. *Periplaneta banksi* Hanitsch, 1931: **A** Adult female **B** head **C** prothoracic leg **D** tarsal claws **E** male genitalia: (L1-3: left phallomere sclerites; L2v: L2 ventral sclerite; R1-3: right phallomere sclerite; vph: ventral phallomere) **F** L2v close-up **G** male supra-anal plate **H** female subgenital plate.

Remarks. Hanitsch (1931) described *P. banksi* from a single female specimen from the Philippines without any further details on its collection locality. Asahinai (1980) later described another female specimen from Taiwan. This is the first time the male of this species is described.

The species resembles *P. lata* (Herbst, 1786), but differs primarily by its larger size. Bruinjing (1948) noted the possibility of the two species being synonyms, but a detailed examination of the male genitalia of *P. lata* is needed to confirm this.

Family Blaberidae Saussure, 1864

Subfamily Pycnoscelinae McKittrick, 1964

Genus *Pycnoscelus* Scudder, 1862

Pycnoscelus striatus (Kirby, 1903)

Figure 3

Leucophaea striata Kirby, 1903: 378 (Lectotype: ♂, Batu Cave, Selangor, Malaysia, BMNH, designated by Princis 1956); 1904: 151; Hanitsch 1915: 122, 163; Chopard 1919: 358; Hanitsch 1923: 445, 466.

Pycnoscelus striatus, Chopard 1924: 82; 1929: 367; Hebard 1929: 14; Hanitsch 1929: 266, 287; Hanitsch 1933: 303, 327; Bruinjing 1948: 41, 145; Princis 1958: 70; 1964: 274; McClure 1965: 55; McClure et al. 1967: 418; Roth 1973: 251; Roth 1980: 103; 1998: 117; Price 2004: 314; Lucañas et al. 2015: 2.

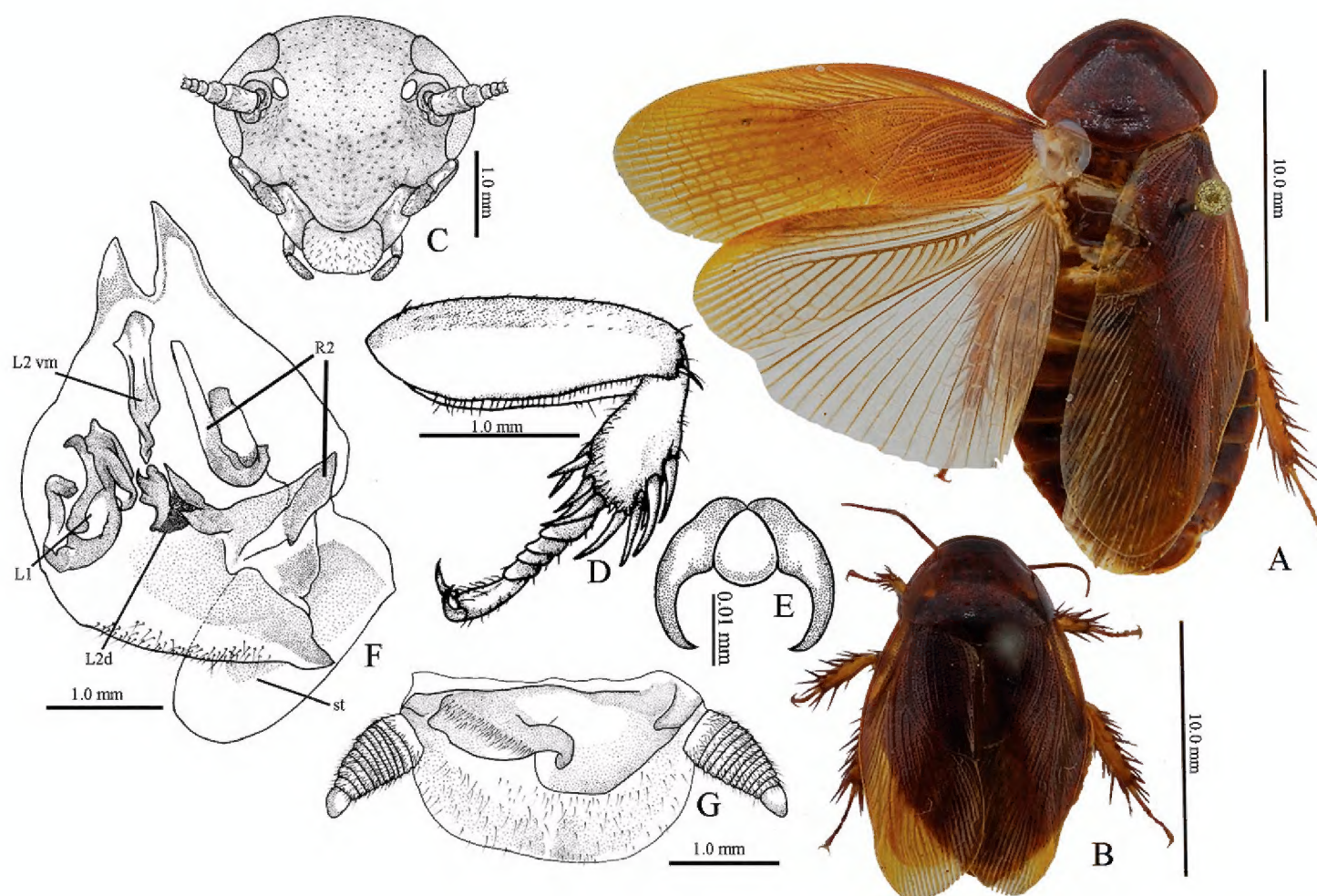


Figure 3. *Pycnoscelus striatus* (Kirby, 1903): **A** Adult female **B** adult male **C** head **D** prothoracic leg **E** tarsal claws **F** male genitalia (st: right style; L1-2: left phallomere sclerites; L2d: L2 dorsal; L2vm: L2 ventromedial/ median sclerite; R2: right phallomere sclerite) **G** male supraanal plate.

Material examined. 22 males, 15 females, 38 nymphs: Philippines: Polillo Island (Quezon Province): Bulalon Cave, Poblacion, Burdeos, v.2010 (JMA Encinares, UPLBMNH BLA-00443-00455 and -00500-00505, ♂; -00456-00466, ♀; -00467-00497, nymphs), 24-27.ii.2007 (IL Lit, Jr/ OL Eusebio, UPLBMNH BLA-00507-00509, ♀); Cave 2, Sitio Puting Bato, Barangay Aluyon, Burdeos, 23.ii.2013 (CC Lucañas, UPLBMNH BLA-00517, ♂; -00518, ♀), 23.v.2013 (CC Lucañas, UPLBMNH BLA-00524 ♂; -00522-00523, nymphs); Cave 3-4, Sitio Puting Bato, Barangay Aluyon, Burdeos, 23.ii.2013 (CC Lucañas, UPLBMNH BLA-00511, -00515, ♂; -00512, -00516, ♀; -00513-00514, nymphs); Cave 5, Sitio Puting Bato, Barangay Aluyon, Burdeos, 24.ii.2013 (CC Lucañas, UPLBMNH BLA-00519-00521, nymphs).

Description. *Size* (mm): ♂ TL: 14.25 ± 1.32 ; BL: 13.59 ± 1.15 ; Pn: $4.57 \pm 0.42 \times 5.91 \pm 0.65$; Tg: 9.68 ± 1.56 ; ♀ TL: 21.39 ± 1.91 ; BL: 17.67 ± 1.97 ; Pn: $5.97 \pm 0.40 \times 7.42 \pm 0.43$; Tg: 16.67 ± 1.91 .

Male. Often less than half the size of females. Vertex exposed. Ocelli present. Pronotum rhomboid, almost as long as wide, reddish-brown, densely punctured. Tegmina variable, reaching slightly beyond abdomen or reaching only up to 7th abdominal tergite. Fore femur C_1 . Mid- and hind femur unarmed. Pulvilli present on four proximal tarsomeres. Hind metatarsomere slightly longer than succeeding tarsomeres combined. Tarsal claws simple, symmetrical. Arolia minute. Abdominal tergites un-

specialized. Supraanal plate entire, testaceous. Genitalia as illustrated. Left style absent. Right style ovoid, rounded apically. Genital hook on right side.

Female. Almost similar to males except larger and robust. Wing size highly variable. Subgenital plate entire.

Distribution. Malaysia (Malacca), Indonesia (Sumatra, Kalimantan), Philippines.

Ecology. McClure (1965) noted that *P. striatus* reaches very high population density, reaching up to 3000/m² of guano on Batu Caves, Malaysia. Similarly, individuals from Cave 3-4 form dense populations in thick guano from the fruit bat *Rousettus amplexicaudatus* (Geoffroy, 1810), but are also found in small population on dark zone with thin guano from insectivorous bats. They classified as guanobytes as they burrow beneath layers of guano. They are found together with and may serve as prey to *Phlogiellus kwebaburdeos* Barrion-Dupo et al., 2014 (Barrion-Dupo et al. 2014, Rasalan et al. 2015), scutigerid centipedes, *Scutigera* sp. and some whipspiders, *Charon* sp.

Remarks. Roth (1998) reported a female specimen collected from bat guano in Manhuyod or Negros. Roth temporarily assigned it as *Pycnoscelus* sp. C. due to the absence of a male specimen, but stated that it closely resembles *P. striatus*. The specimen is deposited in the Zoological Institute, Department of Systematics, Lund, Sweden. Several specimens collected from Burdeos have the same interocular width as *Pycnoscelus* sp. C (2.3mm), while some fit with *P. striatus* (1.5-1.7mm). Therefore, it is possible that *Pycnoscelus* sp. C is a variation of *P. striatus*. Additional specimens, particularly from the same collection locality of *Pycnoscelus* sp. C, are needed to confirm this.

The foregoing description of the right style (*i.e.* rounded apically) differs from that of Roth (1998), which he illustrated as acute apically.

Pycnoscelus sp. D

Figure 4A

Material examined. 3 females: Philippines; Polillo Island (Quezon Province): Cave 2, Sitio Puting Bato, Barangay Aluyon, Burdeos, 23.v.2013 (CC Lucañas, UPLBMNH BLA-00525-00526), v.2010 (JMA Encinares, UPLBMNH BLA-00527).

Description. *Size* (mm): ♀ TL: 21.5 ± 0.71; BL: 18.5 ± 0.71; Pn: 6.5 ± 0.71 × 8.5 ± 0.71; Tg: 17.5 ± 0.71.

Male: Unknown

Female: Body generally convex. Vertex concealed. Ocelli present. Pronotum medially wider than long, black throughout except for yellow anterolateral markings, minutely punctate. Tegmina well-developed extending beyond abdomen, hyaline black-brown. Fore femur C₁. Hind basitarsus longer than succeeding tarsal segments combined. Pulvilli present on four proximal tarsomeres. Arolium large. Tarsal claws symmetrical. Abdomen medially brown, darkening distally.

Ecology. The species was collected on thick guano piles of mix bat populations in Cave 2. In contrast with *P. striatus*, the species was present only on the top layer of the guano and does not burrow much even if disturbed.

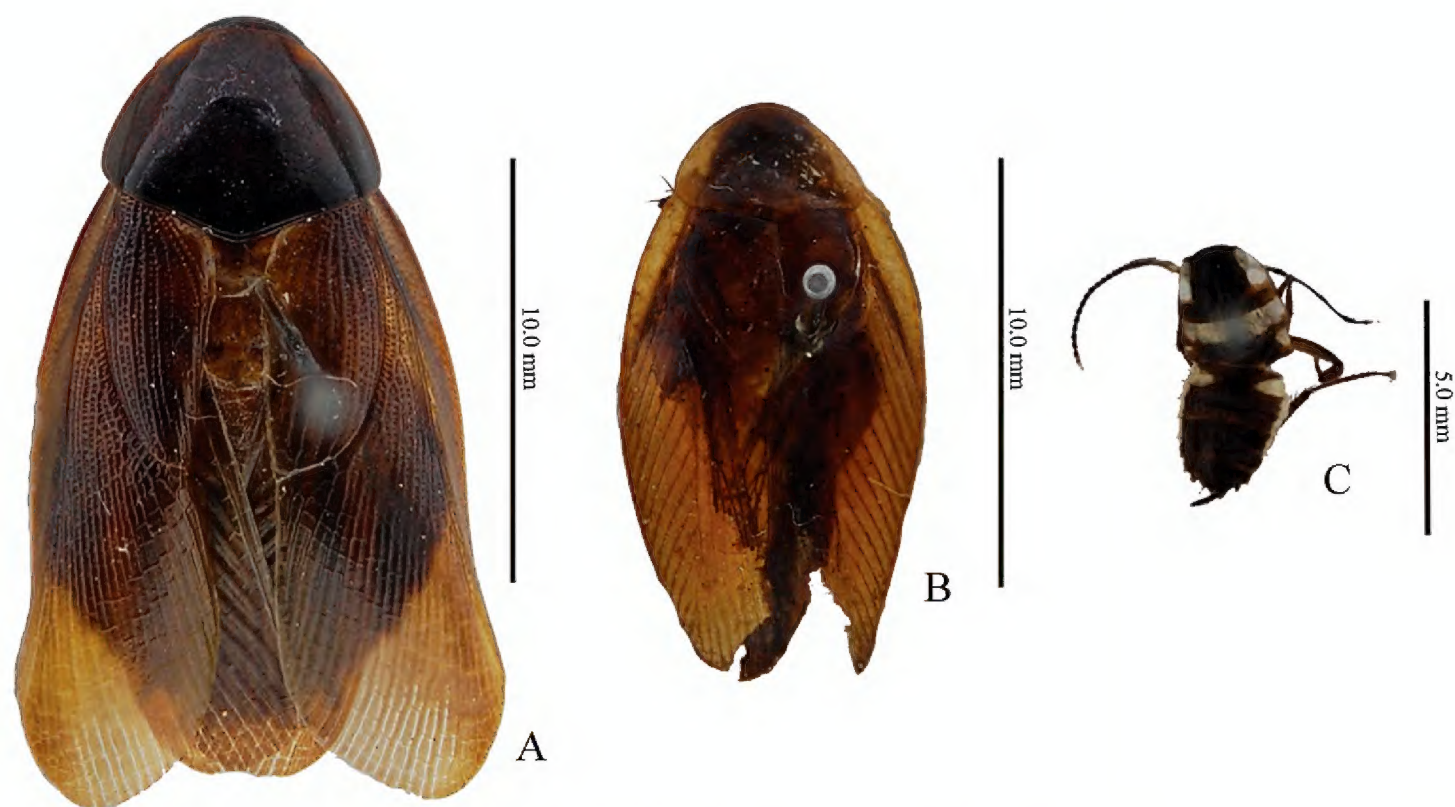


Figure 4. Other cave cockroaches from Polillo Island, Quezon: **A** Blaberidae: *Pycnoscelus* sp. **D** adult female **B** Ectobiidae: *Shelfordina* sp., adult female **C** *Hemithysocera* sp., early instar nymph.

Remarks. This species or form is closely similar to *P. striatus* and may prove to be only a variation. For now, it is treated separately because of its darker coloration, robust abdomen, rather convex body, large arolia and the presence of narrow anterolateral band on its pronotum. The absence of a male specimen hinders further identification.

Roth (1998) described unverified species of *Pycnoscelus* and temporarily assigned them as spp. A, B and C. In order to avoid confusion, this specimen is temporarily named as *Pycnoscelus* sp. D.

Family Ectobiidae Brunner von Wattenwyl, 1865

Subfamily Pseudophyllodromiinae (temporary name)

Genus *Shelfordina* Hebard, 1929

Shelfordina sp.

Figure 4B

Material examined. 1 female: Philippines: Polillo Island (Quezon Province): Cave 3-4, Sitio Puting Bato, Barangay Aluyon, Burdeos, 01.iii.2013 (CC Lucañas, UPL-BMNH BLA-00533).

Description. Size (mm): TL: 13.50; Pn: 3.00 × 4.00; Tg: 10.00.

Male: Unknown.

Female: Vertex of head slightly exposed. Ocelli minute. Pronotum anteriorly ellipsoid, wider than long, with brown central maculae, anterior and lateral areas hyaline. Fore femur type A2. Mid femora armed with row of spines on outer aspect. Hind

femora missing from specimen. All tarsomeres with pulvilli, 1-3 spined. Tarsal claws symmetrical with minute dentations. Arolium present. Tegmina well-developed.

Remarks. Accidentals. Since only one female specimen was collected and troglomorphic characters are absent, it can be said that its presence in the cave was accidental.

Roth (1990) described *Shelfordina philippensis* from Camarines Sur, but later transferred it to the genus *Margattea* (Roth 1996). Both genera are morphologically similar except for the armature of the fore femora, i.e., type A for *Shelfordina* and B for *Margattea*, and the presence of tergal gland on the eighth abdominal segment in males of *Margattea*.

Subfamily Blattellinae Karny, 1908

Genus *Hemithyrsocera* Saussure, 1893

Hemithyrsocera sp.

Figure 4C

Material examined. 3 nymphs: Philippines: Polillo Island (Quezon Province): Bulalon Cave, Burdeos (v.2010 JMA Encinares, UPLBMNH BLA-00441-00442, nymphs); Cave 3-4 (v.2011 JMA Encinares, UPLBMNH BLA-00532, nymph).

Description. Front femur A2, pulvilli on 4 proximal tarsomeres, tarsal claw simple and symmetric, arolium present. Quite similar to nymphs of *H. silbergliedi* except for the broad lateral white margin of the pronotum and completely black abdomen.

Remarks. Accidentals. This species has been previously recorded only from Bulalon Cave (Lucañas et al. 2015) with only a few early instar nymphs collected inside the cave. Even though *H. silbergliedi* (Roth, 1985) is abundant outside the caves, the slight differences in pronotal coloration and the absence of adult specimens hinders further identification.

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